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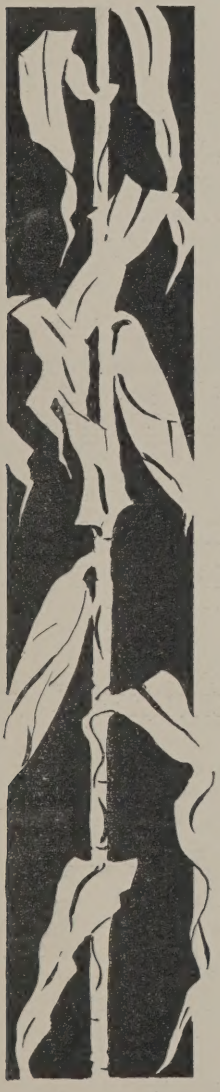
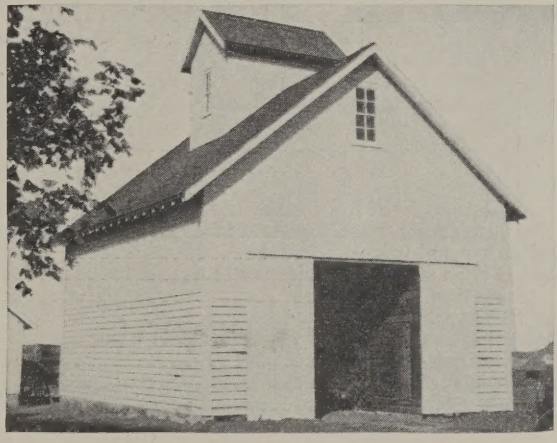
COMMODITY INFORMATION SERIES

CORN STORAGE *in the* EVER-NORMAL GRANARY





CONVERTING SURPLUSES INTO RESERVES BY STORING CORN IN YEARS OF LARGE CROPS FOR USE IN YEARS WHEN CROPS ARE SMALL

U.S. DEPARTMENT of AGRICULTURE
Agricultural Adjustment Administration

CONTENTS

INSURED LOANS
to BUILD—IMPROVE
CORN CRIBS . . .
FARM BUILDINGS . . .
WHEAT BINS . . .

◆ Farmers may now borrow as much as $2,500 under the FHA Plan to build new corn cribs, wheat bins, and other farm structures, including a new farm home.

◆ Loans from $100 to $10,000 are also available for modernizing farm buildings—to make repairs, install heating, wiring, and plumbing systems in the home, enlarge storage buildings, remodel barns, etc.

◆ A farm owner (or lessee under lease expiring not less than 6 months after maturity of the loan) may obtain a Modernization Loan if he has good credit standing and a reasonable ability to repay.

◆ Application is made to any lending institution approved* for making loans by the Federal Housing Administration.

◆ The loan may be repaid monthly or in annual or semiannual installments at seasons of the year when corn, wheat, or other farm produce is marketed.

◆ Up to 5 years is allowed for repayment of loans made for general repairs or for the construction of new farm buildings other than homes. (Up to 7 years is permitted for new homes.)

◆ A Modernization Loan may be made on mortgaged property if the lender is willing. The lender may or may not require security on loans up to $2,500, but on larger loans security is usually taken.

◆ Interest and all charges on loans for non-dwelling construction or for general repairs may not exceed the equivalent of a $5 discount per $100 original face value of a 1-year monthly-payment note.

◆ On loans up to $2,500 for new-home construction, the total charge may not be more than the equivalent of a $3.50 discount per $100.

◆ Under the FHA Plan, if a responsible farmer needed $500 to equip his farm with new grain storage structures and $300 for making other structural repairs, he could apply for an insured loan of $800. The loan could be paid in 3 years at $25.56 a month.

FHA INSURED MORTGAGE LOANS FOR FARM PROPERTY.—New Federal Housing legislation includes farm property in the Insured Mortgage Plan. Now farm land may be purchased, or farms refinanced with an FHA-Insured Mortgage Loan **provided 15 percent or more of the amount of the loan is used to construct or improve buildings on the property.** Monthly or seasonal payments . . . limited interest rate . . . long repayment period.

*FHA-Insured Loans are private loans—not Government money—protected by FHA Insurance. Apply at any bank, building and loan association, or other lending agency approved by the FHA. A list of those in your locality may be obtained by writing to the

BETTER HOUSING FHA PROGRAM

FEDERAL HOUSING ADMINISTRATION—WASHINGTON, D. C.

U. S. GOVERNMENT PRINTING OFFICE 16—7147

THE EVER-NORMAL GRANARY IDEA

The ever-normal granary idea is as old as the ancient civilizations and as new as our modern problems of economic instability. City people are in search of greater economic security, more continuous production, and employment. Farmers likewise seek greater stability in their production, prices, and income. They can no longer bank on world markets taking their bumper crops, and consumers cannot bank on reduced tariffs and greatly increased imports in years of great crop shortages.

Amidst the great dislocations of the past decade in world economic and political affairs there have appeared most extreme fluctuations in weather and crop yields. For example, the worst droughts in a hundred years struck our grain crops in 1934 and 1936, and in 1937 we had record crop production. Weather conditions in most parts of the country have shown greater fluctuations and uncertainties than in former generations.

One of the byproducts of an age of trouble, when the ways of the past no longer serve the common welfare effectively, is an increased effort to discover new devices. Most of the agricultural programs introduced by the Department in recent years might be classed under the ever-normal granary idea. In the soil conservation programs we are searching for the best ways of retaining and increasing soil fertility. In the adjustment programs of the grain and livestock areas we are attempting what thoughtful farmers have been urging for years, a system of storing surpluses for years of deficit, so as to maintain a more continuous flow of livestock products to market at more stable prices for both grains and livestock. In the crop-insurance program for wheat we are enabling wheat growers to cooperate in an effort to reduce the effects of the hazards of production. This insurance plan, if successful, doubtless will be extended to corn, cotton, and perhaps other crops.

These elements of the ever-normal granary idea, as we grow in experience with them, should give us a more orderly farm production to meet all the normal requirements of a growing country both for domestic and export markets. They should give us better control of our natural resources, with great improvement in the storage facilities on farms, more efficient farm management, greater stability in the consumer food budget, and a substantial contribution to the economic stability of all those engaged in the marketing and processing of farm products.

The important steps of providing practical and safe (not elaborate or costly) storage buildings and of caring for farm stored corn so that it will not deteriorate can be taken only by farmers themselves. Farmer cooperation in carrying out the requirements that are outlined in this publication is needed in giving effect to the whole idea.

H A Wallace

CORN STORAGE IN THE EVER-NORMAL GRANARY

This bulletin[1] *was prepared by representatives of the Agricultural Adjustment Administration and of the Bureaus of Agricultural Economics, Agricultural Engineering, Biological Survey, Entomology and Plant Quarantine, and Plant Industry of the Department of Agriculture, with the assistance of engineers and agronomists of the agricultural colleges of Illinois, Indiana, Iowa, Kansas, Maryland, Ohio, and Oregon.*

The Ever-Normal Granary aims to convert crop surpluses into reserves. Loans on corn stored under seal will make it possible for farmers to retain part of their crop in years of large production and

FIGURE 1.—The ever-normal granary for corn insures an ever-normal feed supply for livestock and an ever-normal supply of meat for the consumer at stable prices.

low price and have it available for feeding or marketing in years of poor crops or when prices are more favorable. If supplies become burdensome, marketing quotas will be available to adjust marketings to amounts needed during the season and to effect storage for future use. Quotas can be adopted only when supplies reach a high level (more than 10 percent above normal) and when approved by two-

[1] Prepared chiefly for the commercial corn-producing areas. Farmers in other areas, where climatic conditions may differ appreciably from those in the commercial area, should get in touch with their State agricultural college for storage details.

thirds of the producers voting in a referendum. Loans will be available on corn stored under quotas.

The stored corn is the only security the Government will have on its loan investment. To protect the loans, and to make sure that reserve supplies of corn will be available when needed, it is essential that only good quality corn be stored under seal, and that storage buildings be put in shape to afford protection against loss or damage to the stored grain.

Federal loans on farm stored corn will be of greatest significance in the commercial corn-producing area where weather conditions and relatively light insect infestation permit practical and safe storage.

CORN LOANS

The Agricultural Adjustment Act of 1938 directs the Commodity Credit Corporation to make corn loans available during any marketing year: (1) when the November crop estimate exceeds normal domestic consumption and exports, or (2) in any marketing year when on November 15 or at any time thereafter the farm price of corn is below 75 percent of parity.[2] However, if the marketing quota level is reached and farmers vote against the adoption of quotas, no corn loans can be made.

Loans will be made on merchantable corn at the following rates to farmers in the commercial corn-producing area who cooperate in the A. A. A. program:

75 percent of parity if the crop is not larger than is needed for domestic consumption and exports and the farm price is below 75 percent of parity on November 15 or at any time thereafter;
70 percent of parity if the crop is not more than 10 percent above consumption and exports;
65 percent of parity if the crop is from 10 to 15 percent above consumption and exports;
60 percent of parity if the crop is from 15 to 20 percent above consumption and exports;
55 percent of parity if the crop is from 20 to 25 percent above consumption and exports; and
52 percent of parity if the crop is more than 25 percent above consumption and exports.

In the farm act a cooperator in the commercial corn-producing area is defined as a producer on whose farm the planted corn acreage does not exceed the corn acreage allotment for the farm. A cooperator outside the commercial corn-producing area is defined as a producer on whose farm the planted acreage of all soil-depleting crops does not exceed the total soil-depleting acreage allotment for the farm. The rate of loans to cooperating farmers outside the commercial corn-producing area will be 75 percent of the rate to cooperating farmers in the commercial area.

Noncooperating farmers in the commercial corn area will be eligible for corn loans only in years when marketing quotas are in effect. The rate to noncooperators will be 60 percent of the rate to cooperators, and loans to them will be made only on corn required to be stored under marketing quotas.

The Agricultural Adjustment Administration through the State and county agricultural conservation committees will cooperate with

[2] Parity price of corn in June 1938 was 82.8 cents.

the Commodity Credit Corporation in the administration of corn loans. The State committees will instruct and supervise the work of the county committees, and will maintain a laboratory for testing and grading the samples of corn offered as collateral for Federal corn loans. The county committees will instruct the sealers who inspect the storage and the corn offered as collateral for Federal loans, and will certify all loans and maintain supervision over them until the loans are liquidated.

QUALITY OF CORN FOR STORAGE

To be acceptable as collateral for a Government loan, corn must be properly stored and must meet the following requirements:

1. Ear corn must be merchantable, husked field corn containing not more than 20½ percent moisture; deductions in amount of loan will be made if the corn contains more than 15½ percent moisture.
2. Shelled corn stored on the farm must be merchantable, shelled field corn, containing not more than 14 percent moisture.

PRECAUTIONS IN STORING CORN

More than usual caution is necessary in selecting the time to crib corn for long-time storage. The urge to start early is strong. Whether picking by hand or by machine, the producer is anxious to finish before bad weather sets in. However, corn dries out much faster in the field than in the crib, and the risk of loss due to delay in harvesting may be more than offset by spoilage if damp corn is cribbed.

Corn that is killed by frost before maturing may continue high in moisture content until late in the season. It is safest to store such corn as silage, but if it is husked, cribbing should be delayed until cold weather, and additional precautions should be taken to provide ventilation throughout the crib so that if the corn is not fed during the winter it will have a chance to dry out quickly in the spring. Because of the risk involved in holding immature corn after the coming of warm weather and because of the difficulty of drying it sufficiently to meet loan requirements, it should not ordinarily be considered for ever-normal granary storage. Difficulties due to storing immature corn may to a considerable extent be avoided by planting the earlier maturing varieties for that portion of the crop that is to be held in the ever-normal granary.

The method of filling the crib influences the keeping of the corn. Spreading the corn out as much as possible permits drying during the filling operations, and also reduces the strain on the walls and braces of the building.

If the crib is filled by hand, there will be little trouble from excessive concentration of shelled corn, husks, and silks. When elevators are used for filling, they should be equipped with screens to remove as much shelled corn and trash as possible, and the delivery spout should be moved frequently to prevent accumulation of large masses of shelled corn and trash that are likely to heat and spoil. Clean husked corn keeps better than that containing husks, silks, or broken kernels.

HOW TO ORDER PLANS

Working drawings and bills of materials for crib designs shown in this bulletin may be requested from the extension service of your State agricultural college or from your county agent. Refer to the design number given in this bulletin.

REQUIREMENTS FOR CRIBS UNDER THE FEDERAL LOAN PROGRAM

The following pages discuss types of cribs that are used successfully on farms in the various sections of the country. The principles of safe storage are described and common faults illustrated so that farmers can put their cribs into condition to meet loan requirements or provide new buildings before the corn is ready to crib this fall. Briefly stated, the requirements are that *cribs must provide adequate ventilation facilities to condition the corn properly, and be so located and of such substantial construction as is necessary to afford protection against weather and rodents for a period of not less than 2 years.* Cribs must be completely and securely enclosed and sealed in such a manner as to require a forceful breaking to make entry into them. Cribs that do not meet requirements can often be repaired or remodeled so as to do so at reasonable cost.

CRIB TYPES

In order to avoid molding and spoilage after the coming of warm weather, ear corn must throw off a large amount of moisture during the drying weather of the early spring. This is possible only if there is free circulation of air through all parts of the crib.

The most important dimensions to be considered in connection with all corn cribs is the width. Corn of high-moisture content is most likely to dry in a narrow crib because the narrower the crib the freer the movement of wind through the corn. Corn stored in a crib 10 feet wide and 7 feet high will often spoil, while an equal volume of the same quality corn stored in a crib 7 feet wide and 10 feet high will dry out and keep safely.

The proper width for a corn crib in a particular locality depends upon the maturity of corn in ordinary seasons as well as upon the prevailing weather conditions during the first 6 months of storage. Average date of killing frost, relative humidity of the air, temperature, sunshine, and amount of wind all serve to determine the proper width of a crib. While these conditions change from year to year, a careful study of the available information indicates that widths of rectangular cribs in the commercial corn area should not be greater than those shown on the map in figure 2. In ordinary seasons most corn will dry out properly in cribs of these widths, but if corn is immature or unusually moist when cribbed, or if the crib is wider than recommended, one or more of the ventilating devices shown in figure 16 should be employed.

RECTANGULAR CRIBS

Single cribs of wood, metal, or masonry with shed-type roofs are generally satisfactory for storing moderate quantities of corn. A

crib 7 feet wide, 10 feet high, and 32 feet long will hold about 800 bushels of ear corn, or slightly more if it is refilled as the corn settles. It is desirable to have single cribs face south or east to protect the stored corn in times of heavy snow with high winds.

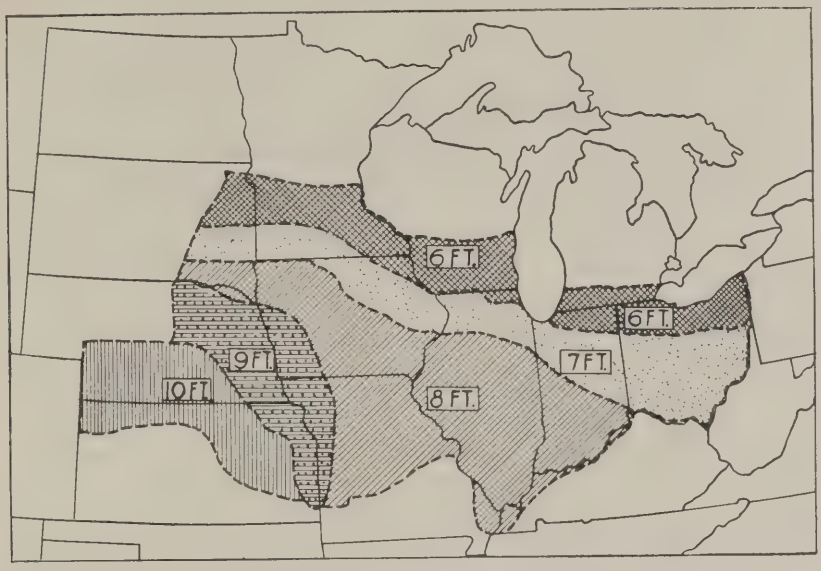


FIGURE 2.—Map showing recommended maximum widths for rectangular cribs in the commercial corn area.

FIGURE 3.—A substantial and acceptable type of single crib.

If the crib is faced east and more space is needed later, it can be converted into a double crib by setting a second unit facing it and about 11 feet to the east, then roofing the space between. Figures 3 and 4 show good types of single cribs.

Single cribs with gable roofs apparently do not give as satisfactory results as cribs constructed with shed-type roofs. The gable

roof seems to cause a greater accumulation of snow in and on the stored corn.

Cribs with sloping side walls have no particular advantage over straight or vertical-sided cribs and do have some objectionable features (fig. 5). They are more difficult to build, have a greater roof

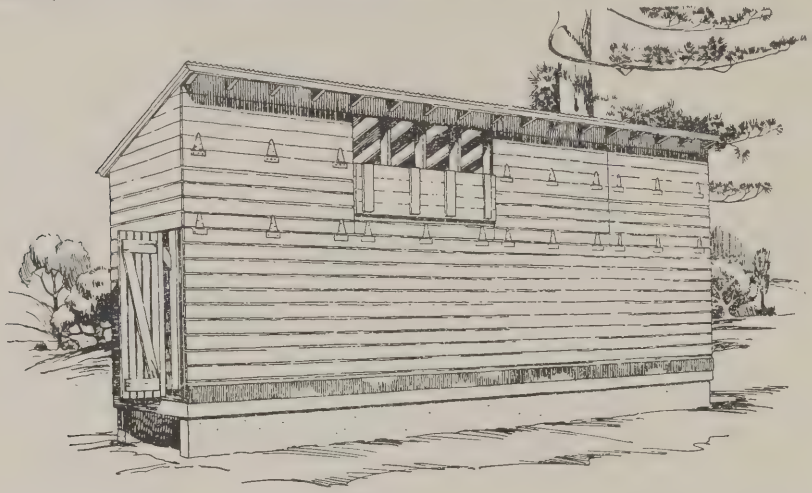


FIGURE 4.—A high narrow crib suitable for storing corn in the northern part of the Corn Belt. Design No. 5533, capacity 700 bushels. By placing a similar unit facing it across a driveway and roofing the space between, this can be converted into a double crib.

FIGURE 5.—A single crib with gable roof and sloping side walls; more difficult to construct than the type shown in figure 4.

area for the capacity of corn, and the side walls become weakened sooner because of the weight and pressure on them. Beveled boards, spaced not more than 1 inch apart, will offset any advantage the sloped wall might have in shedding water, and it is doubtful that cribs with sloping walls provide more circulation of air through the corn than high, straight-sided cribs under similar conditions.

Double cribs.—Double cribs of moderate width and ample height are very desirable storage structures (fig. 6).

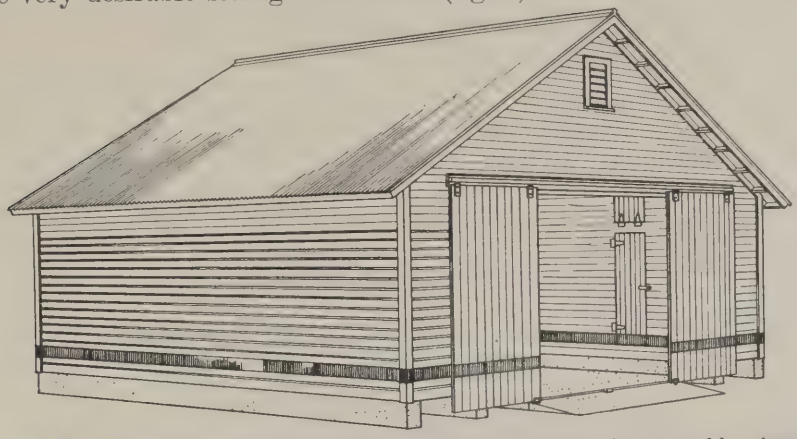


FIGURE 6.—A good type of crib and granary for filling with portable elevator. Design No. 5535. Capacity 900 bushels of ear corn, and 2,000 bushels of small grain.

It is usually advisable to set a double crib with the ridge north and south so that both sides of the building have equal exposure to sun and wind. This is desirable for both the crib structure and the stored grain. Driveway doors should be left open in drying weather, so that the winds may cause a more effective circulation of air through the stored corn.

Double cribs with overhead bins.—Combination storage for ear corn and small grain in double cribs with overhead bins is very popular in the commercial corn areas. Figure 7 illustrates a structure

FIGURE 7.—A double crib with inside elevator. Capacity 3,200 bushels of ear corn. The bins over the driveway provide good storage for 2,000 bushels of shell corn or wheat. Design No. 5534.

of this type. Such structures afford excellent storage for ear corn, shelled corn, and wheat, except in the southern part of the area where insect infestation makes it desirable to store ear corn in a separate building from other grain.

Cribs with grain bins over the driveways usually have greater height than other types; therefore they offer more obstruction to the wind and obtain correspondingly greater air circulation through the corn. Because of the greater wind pressure, and because more settlement of corn takes place in high cribs, it is very important that the upper 3 to 5 feet of the crib walls be tightly boarded in order that air currents may not carry snow or rain over the top of the corn if it settles below the roof line. When the crib is not filled to normal capacity, such protection may be provided by lining the portion of the crib above the top of the corn with heavy paper held in place by laths. The wind will produce sufficient upward draft in most cases to condition the corn in the upper parts of the crib even though the upper portions of the walls are not slatted.

Covered overhead bins in a large crib are well suited for storing shelled corn and wheat because they are above any danger from ground moisture, and are less likely to be attacked by rodents.

CIRCULAR, OVAL, OR MANY-SIDED CRIBS

A round crib is more economical of materials and easier to brace than one of other shape, but such cribs if large enough to store 500 bushels or more of ear corn are much more difficult to ventilate properly than rectangular cribs. They provide more satisfactory storage in the areas of dry, mature corn than in the more humid areas where the corn is higher in moisture content and drying weather does not come until late in the spring. There are two reasons for this: First, the wind does not exert as much pressure against a circular building as against one that is rectangular; second, to obtain capacity the diameter of a circular crib must be greater than the width of a rectangular crib and therefore the resistance to air flow in the circular crib is more than in the rectangular one. It is necessary to install ventilating flues in cribs of these types, but such flues cannot be expected to produce as much air movement through the grain as takes place in a rectangular crib of proper width. Corn to be stored in a circular crib, especially one of large size, should be allowed to dry as much as possible before it is put into the crib, and special care should be taken also to screen out shelled corn, silks, and husks during filling, and in cribs filled by elevator to move the spout frequently so that corn shelled from falling ears will not accumulate in large masses. Only well-matured corn should be stored in a wide crib of any shape or material if it is intended to be held after warm weather sets in.

Prefabricated cribs.—Wood or perforated steel cribs of oval, oblong, round, hexagonal, or other shape, are often prefabricated and sold to farmers ready to set up. Care should be taken to see that such cribs are strongly constructed, not too large in diameter, and that they have well-ventilated outside walls, together with a center ventilating flue. The diameter of a round or manysided prefab-

ricated crib should not be more than about one and one-half times the widths shown in figure 2 for rectangular cribs in the same area. The center flue should be a foot or more in diameter, with frequent openings on all sides, and connected to a substantial and adequate suction ventilator at the peak of the roof.

Masonry cribs.—Masonry cribs of ventilated concrete staves or clay tile are ordinarily large structures of round or oval shape, and since they are often 20 feet or more in width with sidewalls 20 to 25

FIGURE 8.—A large tile granary which is rat proof and fire resistant. Tight walls should extend down from the eaves several feet to prevent the rain and snow from being blown into the crib when not entirely filled with corn. Such cribs need large ventilating flues to condition the corn properly. Large windows or other ventilators in the cupola are needed to let damp air escape.

feet high, it is necessary to use ventilation flues. Because of size, and lack of proper ventilation facilities, such cribs have sometimes failed to condition corn properly. Ventilation flues in large masonry cribs must be self supporting, and strongly braced so that they will resist crushing from movement of corn when the crib is being filled or emptied. Type F of figure 16 is best adapted for use in such cribs and is usually braced only to the plates of the roof. The diagonal slatting stiffens the flue, and the spreading base gives it

stability. Number and spacing of flues should be such that no spot in a crib of this type will be farther from a wall or a ventilator than half the safe width of crib for the locality as given in figure 2. For example, two large vertical flues should be used in a 24-foot oval crib with driveway if located in an area where the width of a rectangular crib should not exceed 8 feet. As in the case of rectangular cribs, the upper portion of the walls should be tight to prevent snow or rain from blowing in on top of the corn after it settles or if the crib is not filled above the plate level.

OTHER TYPES OF CRIBS

Experiments are now being conducted to find if there are new types of cribs that will be low in cost, well ventilated, and easily moved. Such cribs, if developed, would seem especially adapted for use by tenant farmers, as they could be moved from farm to farm if necessary.

Temporary cribs are not described in this publication since substantial structures with good roofs and floors are required for long time storage. Cribs of other types than those mentioned will be considered for loans if they meet the service requirements described in the following pages.

Steel cribs.—In the past most steel cribs have been built in a round or oblong shape like steel grain bins, but equipped with center flues and walls of louvered iron. Like round cribs built of other material, round steel cribs present ventilation problems. Apparently, they provide more satisfactory storage in the areas of dry, mature corn than in the more humid areas where the corn is higher in moisture content and drying weather does not come until late in the spring months.

Rectangular steel cribs are now being developed which give promise of meeting the ventilation and storage requirements in a very satisfactory manner. Such cribs are to be of all-steel construction with wire or louvered-steel sides and bottoms and a crowned roof, providing ample ventilation and protection from the weather and rodents. It is proposed to build these cribs in varying sizes with preference for 500-bushel units. These cribs will probably be prefabricated and constructed so as to be set up on the farm either as a portable or permanent structure.

CRIB LOCATION

Part of farmstead group.—The crib should be located in the farmstead group, not only for convenience but also for protection of corn against theft and for early detection of any loss or damage. Location of a crib away from the farmstead group frequently exposes stored corn to theft.

Relation to other buildings.—The corn crib should be built preferably as an individual unit and located at a reasonable distance from other buildings because the more the sides of a crib are exposed to prevailing winds during drying weather, the more quickly the corn it contains will dry out. Separate structures are more exposed to wind, more easily protected against rodents, and ordinarily less subject to fire hazards than cribs attached to other buildings. Fig-

ures 9 and 10 illustrate good and poor exposure to wind and to fire hazard.

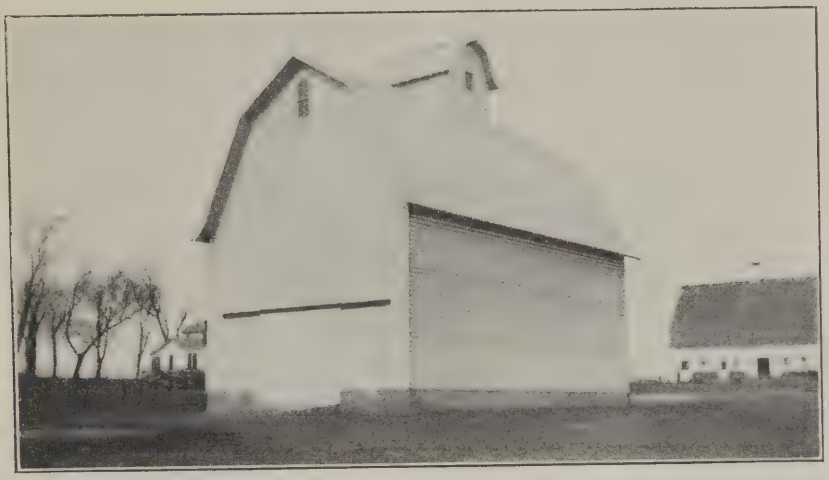


FIGURE 9.—A separate unit in the farmstead group, exposed to prevailing winds and at ample distance from other buildings to minimize fire hazard. Note also high foundation and good drainage.

FIGURE 10.—Other buildings obstruct drying winds, add to fire and rodent hazards, and cause inconvenience in filling. This crib is too wide for northern areas.

In areas of heavy snowfall and high winds, small cribs located near large barns or other buildings may become badly filled by the whirling snow or even buried in drifts.

Cribs built as parts of machine sheds or other buildings which do not house livestock may be acceptable for loans if the cribs are less in width than the acceptable width for the locality. Both side walls must be slatted from the floor to a reasonable height (6 to 8 feet or

more), and must be sufficiently exposed to winds so that ample ventilation reaches all parts of the crib. Extra precaution should be taken to protect the corn in such cribs from rodents.

Cribs should not be built against solid walls of other buildings. Too frequently temporary cribs are built against the end of a barn, machine shed, or granary, in order to save construction costs. When built against a solid wall, the crib will not afford the cross circulation of air needed to dry corn in storage.

FIGURE 11.—A substantial type of double crib with overhead bins and elevator, but located in a barnyard with livestock and poor drainage.

No crib should be built in a barn where livestock is quartered if a Federal loan upon corn stored in the crib is desired. It is practically impossible to construct a crib within a building housing livestock that will provide sufficient ventilation for conditioning the corn. Moisture from the livestock quarters will often cause the corn to spoil. Rodent control is more difficult and the fire hazard greater.

Good drainage.—Good ground drainage away from all sides of a crib location is highly desirable in that the foundation will be less apt to settle unevenly or to be heaved by frost. Corn stored in cribs with low foundation walls located on hill sides may be subject to damage by soil that washes against the crib or by formation of a sheet of ice which causes water to run in on the crib floors. In no case should cribs be located on river or creek bottom lands subject to overflow.

Away from livestock.—Livestock should not be permitted to come in contact with a corn crib. Walls and doors of the crib may be damaged by livestock rubbing and working on them. Too frequently livestock gain access to the stored corn. In the case of double cribs, the presence of livestock prevents the opening of doors to facilitate ventilation in drying weather (fig. 11).

If the crib is located on the lower side of or in a sloping barnyard, the tramping of livestock may force mud and trash against the crib wall until the water runs into the crib instead of away from it.

If hogs are permitted to make deep wallows alongside the crib, the foundation may settle, crack, or actually fall away if made of stone or blocks. This causes crib structures to settle unevenly, and they may actually break open.

Sheep can reach a large amount of corn if the ventilation openings are wide enough so they can insert their noses. Even poultry can do considerable damage around a crib which is not well constructed and well enclosed.

CRIB CONSTRUCTION

FOUNDATION

A good foundation is essential to the life and usefulness of a crib. It should extend into the ground not less than 18 inches to insure stability and to prevent undermining; where frost causes heaving the footings should be below the frost line.

Whatever the type, the foundation should be substantial enough to bear the load of corn and crib without the possibility of its settling to an extent which might cause the crib to warp or break open. On most soils, footings should have a bearing of 1 square foot on the ground for each 50 bushels of ear corn or for each 60 bushels of shelled corn or wheat, and this supporting area should be located according to the load above. If the crib has a wood floor, the top of the foundation should be at least 15 inches above the ground level to provide ventilation and to avoid harboring rats. If the floor is of concrete the height of the foundation will correspond to that of the floor. (See p. 14.)

Concrete walls are probably the most satisfactory type of foundation. For high cribs they should be not less than 10 inches in thickness, set on good footings, with the earth solidly back-filled against the wall to prevent it from tipping.

Concrete piers, stone walls, and stone piers may serve for small cribs but they often settle unevenly, thus causing the structure to break joints, spread, and deteriorate rapidly. Loose rock walls enclosing the foundation attract rats.

Wood sills and piers made from posts, blocks, old railroad ties, planks, and various timbers are often used as foundation supports for small temporary or portable cribs, but they are always subject to decay, and in many areas are seriously damaged by termites. Unless pressure treated with preservatives, they are not suitable for permanent storage structures.

FLOORS

Concrete floors should be at least 8 inches above the ground level on all sides. Low floors are undesirable because they may become wet and cause the corn in the bottom of the crib to spoil. A concrete floor with shelling trench is much more desirable than a plain floor, since it must necessarily be 18 to 24 inches above the ground level; and if the trench is covered with narrow planks, it allows free circulation

of air under and into the bottom of the crib. All concrete floors should be as high as the foundation walls and should be crowned so that any accumulation of water will drain off.

Concrete floors should have a fill of gravel or other material underneath to prevent the concrete from drawing ground moisture, and this filling should be carefully tamped or rolled to firm it and prevent the floor from settling. When shelling trenches are used, the tops of the main walls should be tied together at 4-foot intervals by ½- or ¾-inch steel rods with hooked ends placed when the walls are poured and later embedded in the floor. Reinforcement of the floor with heavy woven wire or steel rods will aid in preventing settlement and cracking. Care should be taken in the construction of concrete floors and shelling trench to prevent openings or cracks which will give rats an opportunity to harbor under the floor.

Spoilage of corn on concrete floors is increased by moisture which comes up through the concrete from below. A layer of hollow tile under concrete floors will break capillary action from the soil but will not provide drainage. *Tile drains under and around the crib and connected to good outlets will keep the ground drier, make the crib more accessible, reduce the danger of frost impairment to the foundation, and make it easier to keep the floor dry.* Concrete floors that are known to be damp should be covered with a layer of boards. Where the ground is poorly drained, a moisture barrier under the boards is a desirable additional safeguard. It may be provided in one of the following ways: (*a*) By painting the concrete when dry with two coats of asphalt aluminum paint, or (*b*) by placing under the boards a layer of vapor-proof paper, such as duplex reinforced Kraft paper or roll roofing.

In the case of new concrete floors the moisture barrier may be provided by allowing the concrete base to set and dry, then mopping it with enough hot asphalt so that the final surface has a high gloss and is smooth, and finally applying 1 inch of cement mortar finish.

Wood floors, if properly constructed, are quite desirable because they allow ventilation through the cracks into the bottom part of the crib, thus providing a circulation of air through the corn where the danger of spoilage is greatest. Rough boards from 6 to 12 inches wide are very satisfactory floor material for ear corn cribs. They provide strength and also afford ventilation openings after they are dried out.

Wood floors must not be loaded beyond the capacity of the joists. Table 1 shows the ordinary safe depth of ear corn to store on joists of common sizes for ordinary spans and spacings. Table 2 shows the safe depth of wheat or shelled corn for storage in bins above driveways of common widths. Joists of old buildings should be carefully inspected for termite damage and decay. Any joist which is split near the center of its height for a length from the end equal to or more than its height is weakened by about one-half. Similar reductions in strength may be caused by large knots, especially if they are near the lower edge of the joist and in the center half of its length. Joists for overhead bins should be of the best quality because of their long spans, heavy loads, and the possibility of accident if they should fail.

All crib floors of wood should be at least 24 inches above the ground level. This height permits good ventilation under the crib and affords

protection against moisture, decay, and damage by termites. Any crib which is high enough above the ground so that cats and dogs can run underneath the floor will be relatively free from rodents.

Some metal cribs are constructed with metal floors. A good precaution before filling such cribs with corn is to lay a board floor on the metal in order to allow some air circulation into the bottom of the crib.

TABLE 1.—*Size of joists required for different widths and heights of cribs*

Length of joists	Type of foundation	Height of crib: 8 feet		10 feet		12 feet		14 feet		16 feet	
		Size of joists	Maximum spacing of joists	Size of joists	Maximum spacing of joists	Size of joists	Maximum spacing of joists	Size of joists	Maximum spacing of joists	Size of joists	Maximum spacing of joists
Feet		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
6	2 walls	2 x 6	16	2 x 6	16	2 x 8	18	2 x 6	12	2 x 8	18
		2 x 8	18	2 x 8	18	2 x 10	24	2 x 10	24	2 x 10	24
8	2 walls	2 x 8	16	2 x 8	12	2 x 8	12	2 x 10	18	2 x 10	16
		2 x 10	24	2 x 10	18	2 x 10	18				
8	3 walls	2 x 6	24	2 x 6	24	2 x 6	24	2 x 6	18	2 x 6	18
								2 x 8	24	2 x 8	24
10	3 walls	2 x 6	24	2 x 6	18	2 x 8	24	2 x 8	18	2 x 8	18
								2 x 10	24	2 x 10	24

NOTE.—This table is based on the ordinary commercial sizes of lumber. If the joists are full size rather than nominal the depth of grain can be increased one-third. If soft, lightweight lumber, such as cottonwood, is used the depth of grain should be reduced one-third.

TABLE 2.—*Size and spacing of joists for overhead bins*

Width of driveway	Depth of grain: 4 feet		6 feet		8 feet		10 feet	
	Size of joists	Maximum spacing of joists	Size of joists	Maximum spacing of joists	Size of joists	Maximum spacing of joists	Size of joists	Maximum spacing of joists
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
9 feet	2 by 8	12	2 by 10	12	2 by 12	12	2½ by 12	12
			2 by 12	16	3 by 12	18	3 by 12	16
10 feet	2 by 8	12	2 by 12	12	2½ by 12	12	2½ by 12	12
	2 by 10	16	2½ by 12	18	3 by 12	16	[1]2 by 12	18
11 feet	2 by 10	12	2 by 12	12	2½ by 12	16	3 by 12	12
	2 by 12	18	2½ by 12	16	3 by 12	12		

[1] 2 joists.

NOTE.—This table is based on the ordinary commercial sizes of lumber. If the joists are full size rather than nominal the depth of grain can be increased one-third. If soft, lightweight lumber, such as cottonwood, is used the depth of grain should be reduced one-third.

WALL FRAMING AND BRACING

Crib walls are subjected to very heavy pressures. For example, the outward pressure on the 2-foot section of cribbing between each pair of studs in the gambrel-roofed crib illustrated in figure 14 is

between 2,000 and 2,500 pounds. In addition the studs carry a downward load of about the same amount due to the friction of the corn on the wall and the weight resting on the cross braces as the corn below dries and settles. It has been found economical to use 2- by 6-inch studs, tied together at 4-foot intervals by a series of cross-braces similar to those shown (fig. 13). These braces strengthen the building against wind when empty as well as resist the bursting pressure of the corn. Even when properly braced, the studs carry heavy loads, and for cribs with walls more than 6 feet high they should not be smaller than 2 by 6's of native oak or of No. 1 yellow pine, fir, or other good lumber.

Proper attachment of studs to floors is very important. Weak fastenings may result in failure like that shown in fig. 12. When

FIGURE 12.—The result of poor construction.

wooden floors are used, the studs can be nailed or bolted securely to the joists and foundation sills. With concrete floors, the studs can be nailed to sills bolted to the foundation but drainage openings should be provided under the sill. Iron anchors embedded in the concrete make very satisfactory connections. Studs should not be set in sockets in the concrete as dirt and moisture will then cause rapid decay.

Proper bracing is one of the most important features of good crib construction. A great amount of material in braces is not necessary, but the proper choice and placing of this material and good fastenings are highly important.

A cross brace of three 1- by 12-inch boards as illustrated in figure 13 has satisfactory tying and bracing strength for cribs in which the total depth of corn is not more than 15 or 16 feet. This type of brace is recommended because a 1- by 12-inch board on edge

will carry approximately one-third more vertical load than a 2- by 6-inch timber on edge, and it also has the advantage of a greater bearing surface on the studs. Also, the use of a large number of nails—12 to 15 eight-penny nails per joint—will give it more holding strength than can be obtained with a 2 by 6, which may split if fastened with large spikes. The 3-point attachment of crossed board braces to each stud is also a very desirable feature. This simple brace is one of the most desirable types and may be used in new cribs as well as in the remodeling of old cribs for greater strength and durability. Such braces spaced 4 feet apart will ordinarily tie and brace the walls sufficiently in cribs of moderate height.

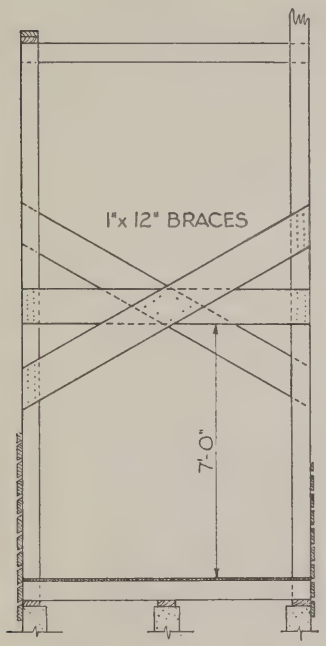


FIGURE 13.—Simple cross brace of three 1- by 12-inch boards.

In combination cribs with bins over the driveway, stronger bracing is needed and may be provided as shown in figure 14. Special care must be taken in fastening the braces to the studs. Fifteen eight-penny nails are needed to make a reliable joint. Larger nails may split the boards. Where there is a board on each side of the stud, six ¼-inch bolts with washers should be used since they give more strength and are not likely to cause splitting. Small bolts cost little and are easily installed, especially if an electric drill is available. Cross ties of wire or steel rods are usually undesirable because the load of corn pulls them down, and this drawing pressure causes the outside walls of the crib to warp out of shape or even to break.

In addition to the cross-bracing, cribs should be braced against end-sway and side-sway by diagonal braces nailed to the studs of each wall inside the corners.

Large masonry cribs are usually constructed by contractors or manufacturers of building blocks. Information regarding cribs of these types may be obtained through these sources or from the State agricultural colleges.

Because of the heavy pressures in high cribs, they should be built from designs prepared by competent engineers or builders experienced in such construction.

WALL COVERINGS

Four-inch cribbing boards afford greater ventilation than 6-inch boards but 6-inch boards can be nailed with less danger of splitting the ends, and will stand greater pressure from the inside. Cribbing subjected to pressure from a height of more than 12 feet of corn should be fastened to the braced studs with three ten-penny nails.

Two nails are enough at the unbraced studs. Beveled boards for outside use are preferred over plain boards because they will shed water, with less chance of moisture penetration into the crib. One-inch spacing of the crib boards will afford sufficient ventilation and ample protection.

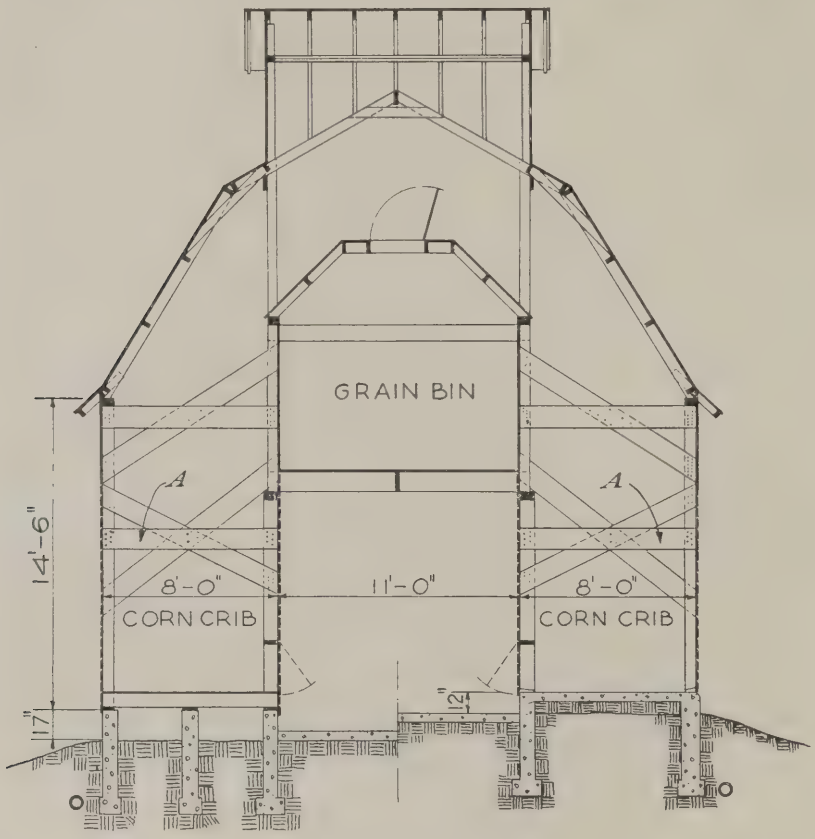


FIGURE 14.—A combined crib and granary with either wood or concrete floor. Note system of bracing studs. Horizontal tie "A" consists of two 1- by 12-inch boards (one on each side of studs), bolted at each end with six ¼-inch bolts. All other parts of cross-brace and upper tie are 1- by 12- inch boards nailed at each end with 15 eightpenny nails. Braces are 4 feet apart.

Horizontal arrangement of crib boards is usually the most satisfactory. Crib boards when applied diagonally on the outside wall may have a bracing effect against end-sway but water running down the boards makes the joints more subject to decay and to consequent breaking loose from inside pressure. If the crib boards are applied diagonally to the inside walls of a double crib next to the driveway, they have the same bracing effect but do not deteriorate because they are protected from the weather.

Vertical siding of cribs is not commonly found outside of areas where the cribs are small and native hard wood lumber is used. If the cribbing boards are securely attached to strong sills, girts, and plates, such cribs may afford acceptable storage for several years.

Where fir and pine lumber are used, horizontal application of crib boards is more satisfactory.

Wire and slat cribbing, if properly stretched and nailed to studs spaced not over 2 feet apart, serves well on semipermanent cribs. Wider spacing of the studs too often causes trouble because of the greater pressure of the corn on the cribbing between the studs. Where wire cribbing is used, crib boards should be used for the first 2 feet above the floor to protect the corn from poultry and small livestock which may gain access to the crib. These boards may be removed to permit the corn to roll out into the conveyor for shelling. Figure 15 shows an arrangement of this kind.

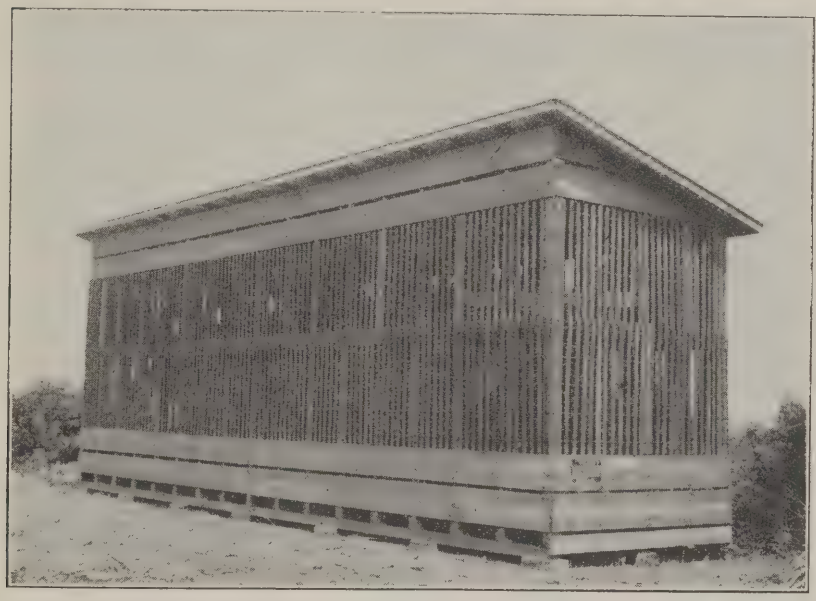


FIGURE 15.—A semipermanent low-cost crib which has furnished acceptable storage. It needs a better foundation. Dimensions, 8 by 32 by 10 feet. Capacity, 1,000 bushels.

Wire and slat cribbing, however, when used on temporary or semipermanent structures, permits extreme exposure of the stored corn. In the past, some such cribs have been accepted for Federal loans, but they may be rejected in the future if it is found that the exposure causes an appreciable deterioration of the quality and quantity of corn during a 2-year period.

VENTILATION

The Federal Corn Loan Program requires that crib walls be slatted or have ventilation openings upward from the floor line. This is necessary to permit a cross circulation of air through the corn. Slatted end-walls are of less importance.

Small cribs should be slatted the full height of the side walls except for 18 to 24 inches of tight siding under the eaves to prevent snow or rain from blowing in under the roof after the corn settles.

High crib walls should be tight-sided downward one-fifth to one-third of the distance from the upper plate line. Tight siding of the upper part of the wall prevents rain and snow from blowing in on the corn when the crib is not entirely filled.

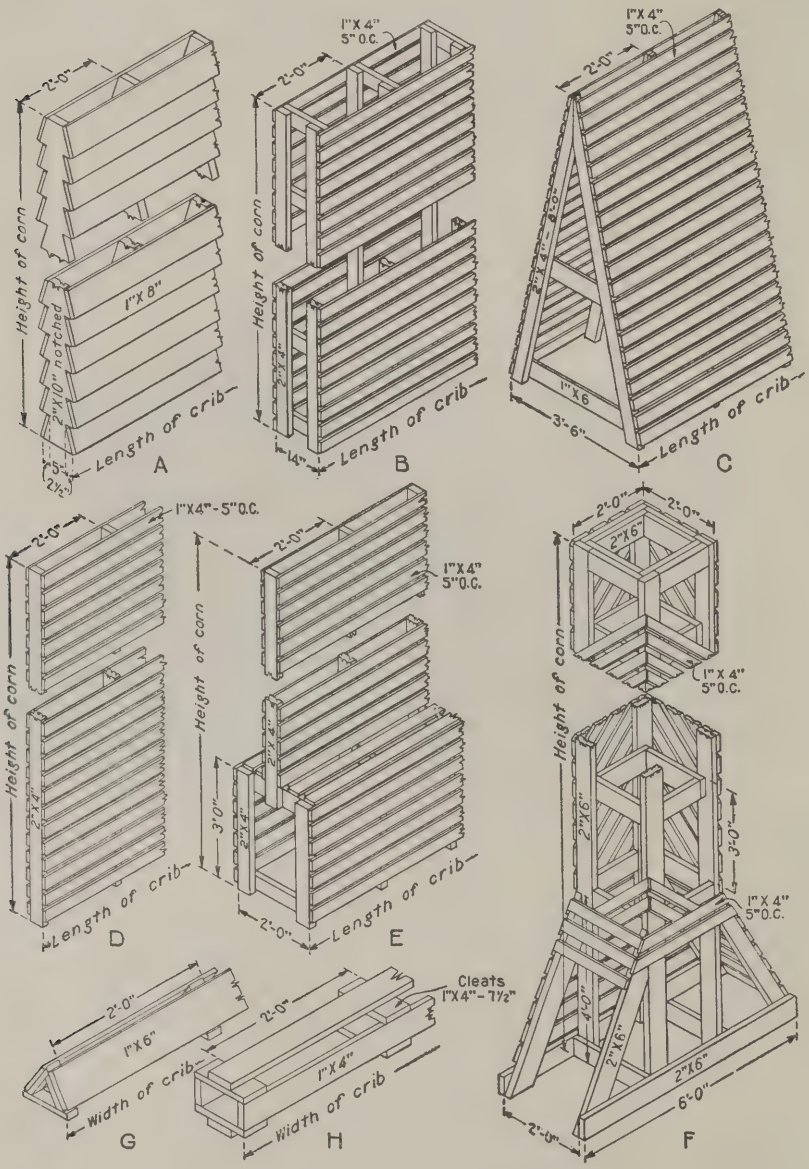


FIGURE 16.—Types of ventilating flues.

Figure 16 shows several forms of ventilators or flues which may be temporarily or permanently placed in cribs to accelerate drying of the corn. Forms A, B, D, and E are built the full length of the

crib and full height of the corn pile. They divide the storage space so that shelling doors are needed on both sides. In long, high cribs the tops of the flues should be braced to the crib walls. Form A may be used in either grain bin or corncrib, as may Form G, if it is closed along the top edge. Forms B, C, and E are commonly used where larger air circulation is needed, as in pop-corn cribs; C is stronger than E; Form F is especially suited for masonry cribs; Forms G and H are used as temporary flues across the crib, and when placed at frequent horizontal and vertical intervals through the corn, they facilitate quick dissipation of the moisture yet are not expensive. Drain tile may be used as horizontal ducts across the crib at several heights.

Where vertical flues are used, as in the large masonry cribs described on page 9, large roof ventilators or window openings should be provided to permit the escape of damp air.

ROOF

A tight, leak-proof roof is essential for safely storing corn. It should be constructed of substantial material and should be well fastened to resist severe winds and unfavorable weather conditions.

Steel roofing is suitable for cribs if securely nailed to the rafters and to 2-inch cross girts. It is rigid, and affords some protection against fire. New roofs of galvanized metal should be not less than No. 28 gauge, and should have a minimum coating of 2 ounces of zinc per square foot.

When wood shingles are used on single cribs, they should be well laid and nailed securely with rust resistant nails to prevent lifting by strong wind pressure inside the building.

Roll roofing is unsatisfactory for use on cribs because of the wind hazard. Asphalt shingles are usually short lived for the same reason.

RAT PROOFING

Rats and mice sometimes cause heavy losses of corn through the winter. They also do considerable harm to cribs.

The use of concrete in constructing foundations and floor helps to exclude rats from the crib. Wood floors built a few inches off the ground furnish harbors for them, and if a crib is set too close to the ground, rats in burrowing will pile moist earth against the floor joists and sills and this will often cause early rotting.

Heavy wire netting of one-half inch mesh, carried entirely around the crib to a height of not less than 2 feet above the ground surface with an 8-inch strip of galvanized iron just above the netting, will keep rats from getting through the crib walls. The netting and strip should be carried around the doors and door frames. The ends of the shelling trench, if one is used, should also be covered with netting. Old cribs can often be rat proofed in these ways at little expense. Metal cribs supply good protection against rats. Some masonry cribs must be screened. Tools, boards, and other objects should not be left leaning against the sides, thus affording rodents access to the crib.

Small buildings may be kept free from rats and mice by the periodical use of carbon monoxide gas from the exhaust of automo-

biles or tractors (fig. 17). All small openings should first be closed with burlap or other packing and the exhaust piped into the building with a short length of hose pipe. The engine should be allowed to run at moderate speed for 10 minutes or more for small buildings.

This method of fumigation has been found practical and reliable, and is inexpensive. Other ways of controlling rats are described in Farmers' Bulletin 1533, Rat Control.

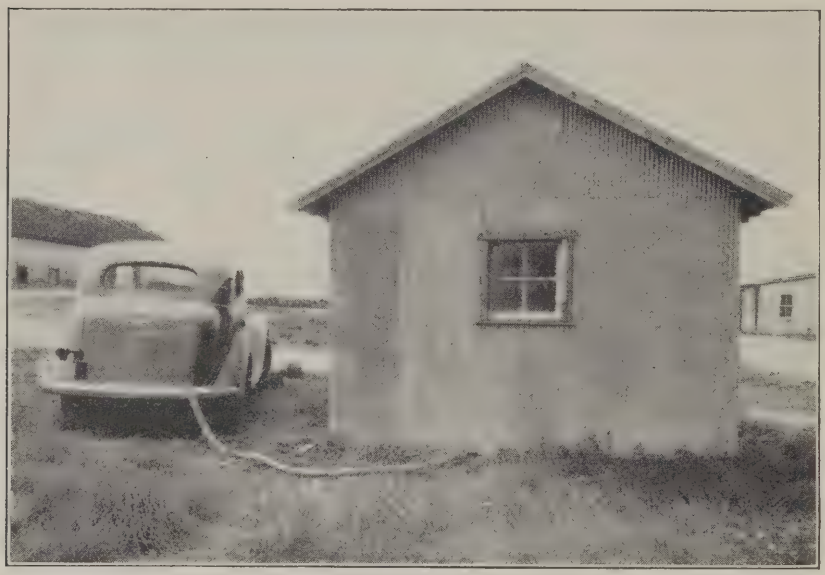


FIGURE 17.—Using exhaust gas to kill rats under cribs or granaries.

ELIMINATION OF FIRE HAZARDS

Fire risks in and about the crib should be reduced to a minimum. If possible the crib should be located apart from the other farm structures and on the windward side. If electric motors or gasoline engines are used in the crib, they should be dustproof or enclosed in a metal-lined room properly safeguarded against fires. Electric wiring, switches, and connections should be well protected so as to reduce the danger of sparks.

If feed grinders, mixers, or cleaning equipment are installed in the crib, provision should be made for collecting the dust or for conducting it outside the building. Machinery and equipment should be installed and protected so as to reduce to a minimum the dangers of dust explosions.

PROVISIONS FOR SEALING STRUCTURE

No crib should be sealed until it is fully enclosed. It is preferable that it be entirely boarded from below the top level of the corn up to the roof, but woven wire, well nailed, will serve the purpose for enclosing the upper part of the inside wall of a double crib. All doors, or other openings, except the one to be sealed, should be securely

nailed. The crib, to be eligible for sealing, must be completely and securely enclosed. It must be sealed in such a manner as to require a forceful breaking to make entry into the crib and thereby gain access to the corn.

SHELLED CORN STORAGE

Shelled corn as collateral for Federal corn loans may be stored in structures licensed under the Federal Warehouse Act or in appropriate and properly constructed farm granaries. In one important respect the storage of shelled corn is radically different from storage of ear corn, for while ear corn will dry a good deal if properly cribbed, shelled corn will dry little if any in the bin, and therefore must be dry when stored. To be safe for farm storage, shelled corn should not exceed 14 percent in moisture content.

SHELLED CORN STORAGE REQUIREMENTS UNDER FEDERAL CORN LOAN PROGRAM

The bin or granary used for farm storage of shelled corn should be a substantial and permanent structure designed to accomplish the following purposes:

1. Hold the shelled corn without loss of quantity;
2. Protect the corn against weather conditions which may cause deterioration in quality;
3. Afford protection against thieves, rodents, birds, poultry, and livestock;
4. Permit fumigation for the destruction of insects;
5. Provide reasonable protection against fire and wind; and
6. Require forceful breaking for entry when sealed.

LOCATION

The general location and surroundings of the bin or granary for shelled corn storage should be similar to those recommended for ear corn storage. Additional emphasis should be placed on the segregation of such storage from other farm buildings, because of the increased fire hazard if it becomes necessary to fumigate the corn for insect infestation.

STRUCTURAL REQUIREMENTS

Foundation.—Requirements for foundations are similar to those already given for cribs (see p. 13).

Floors.—Wood floors must not be loaded beyond the capacity of the joists. Table 3 shows the ordinary safe depth to store corn on sound joists of common sizes for ordinary spans and spacings. For overhead bins see Table 2.

TABLE 3.—*Safe depths of shelled corn in ordinary bins with joists of common sizes and spans for 24-inch, 16-inch, and 12-inch spacings*

Size of joist	Depth of corn for				
	6-foot span	7-foot span	8-foot span	9-foot span	10-foot span
	Feet	*Feet*	*Feet*	*Feet*	*Feet*
24-INCH SPACING					
2 by 6 inches	3				
2 by 8 inches	4½	4	3		
2 by 10 inches	6	5	4	3½	3
2 by 12 inches	8	6½	5	4½	4
16-INCH SPACING					
2 by 6 inches	4½				
2 by 8 inches	6½	6	4½	3½	3
2 by 10 inches	9½	8	7	5½	4½
2 by 12 inches	12	10	8	7	6
12-INCH SPACING					
2 by 6 inches	6	4			
2 by 8 inches	9	8	6	5	
2 by 10 inches	12	10	8½	7½	6
2 by 12 inches	16	13	11	9½	8

NOTE.—This table is based on the ordinary commercial sizes of lumber. If the joists are full size rather than nominal the depth of grain can be increased one-third. If soft, lightweight lumber, such as cottonwood, is used the depth of grain should be reduced one-third.

A tight floor is required to hold the grain and prevent escape of the fumigating gases. Old leaky floors should be covered with new flooring with paper between the new and old layers. Sections of the floor that have been cut by rats should be covered with tin or with hardware cloth before the new flooring is laid.

As in the case of cribs (p. 13), concrete floors in bins that are to be used for long-time shelled-corn storage should be at least 8 inches above the ground on all sides, and should be underlaid with hollow tile or coarse gravel and floors should be covered with loose boards to reduce spoilage of corn on the floor. Except in the driest localities, concrete floors that are less than 8 inches above the ground, and on which shelled corn is to be stored, should be raised by means of board overlays on wood joists. The space between the concrete and board floor should be ventilated and screened to keep out rats and mice.

Walls.—Walls for bins must be strong enough to withstand the pressure of the shelled corn. The size and spacing of studs affect the strength of the walls. Table 4 shows the safe depth of corn for common size and spacing of studs in sound condition.

TABLE 4.—*Safe depth of shelled corn in ordinary bins with studs of common sizes and spacings*

Stud size	Spacing center to center	Depth of bin	Depth of corn	Stud size	Spacing center to center	Depth of bin	Depth of corn
	Inches	*Feet*	*Feet*		*Inches*	*Feet*	*Feet*
2 by 4 inches	24	8	4	2 by 6 inches	24	8	7
2 by 4 inches	16	8	6	2 by 6 inches	16	10	8
2 by 4 inches	12	8	7	2 by 6 inches	12	10	9

NOTE.—This table is based on the ordinary commercial size of lumber. If the studs are full size rather than nominal the depth of grain can be increased one-third. If large knots occur in any of the studs or if the lumber is soft and lightweight, ties should be used across the bin. Studs should be well fastened to the floor system.

Bin walls must be tight. Preferred construction for frame bins calls for two thicknesses of material on the outside of the studs, with a layer of good paper between, and no lining inside the studs. Sheathing may be of shiplap or matched boards. At least 2 tenpenny nails should be used per board for the bottom half of bins not more than 10 feet deep. Waterproof paper should be placed on the sheathing and covered with lap or drop siding, shingles, or sheet metal. Siding should be nailed to the studs, not to the sheathing.

Old bins should be carefully checked before filling. Loose boards should be renailed and all defects in the wall repaired. Single walls of plain boards may be made tight by applying building paper and an additional layer of siding, or by an inside lining of matched boards. The lining should start 4 inches above the floor to leave space for cleaning out corn that leaks through. All holes where rodents might enter the wall should be blocked. Structurally sound walls which are not gas tight can be lined with a strong grade of paper to make fumigation practicable. Weak walls may be strengthened by using board cross-ties or tie rods.

Masonry walls should be thoroughly pointed up on the outside and waterproofed to prevent rain from driving through. Unless the wall is known to be dry, it should be furred with 2 by 2's and lined with matched lumber, with an opening at the bottom of the lining for cleaning. Metal bins should be examined, missing bolts replaced, and all joints drawn tight. Partitions should be grain-tight and as nearly gas tight as possible. It is desirable to extend protective partitions to the roof or ceiling to protect grain from theft. Where this is not done the openings must be closed with woven wire to prevent unauthorized entry to the bin.

Roofs.—The roof should be substantial and watertight. Any standard roofing material is acceptable if in good condition, except that roofs covered with tarred felt or similar lightweight materials are not suitable.

Doors and windows.—All doors and windows must be weatherproof, and safe against leakage of shelled corn. They also should be tight enough to hold gases during fumigation. For this reason they should be covered on the inside with tough paper before corn is placed in the bin. The paper should overlap the entire opening and the jambs. The main entrance door should be fitted with safety hasp for padlock or other seal. All other openings should be fastened on

the inside or nailed shut so that no unauthorized person may enter the bin or remove the grain.

Ceilings.—If there is storage space above the bin, a tight ceiling should be provided to protect the grain from foreign material.

PROTECTING FARM-STORED CORN FROM INSECT ATTACK

Ear corn stored in cribs on the farm is not protected from attack by insects, and fumigation is impractical. Insects may cause serious damage to ear corn stored in cribs in the southern portion of the commercial corn area, particularly in the spring. In areas where ear corn is subject to insect attack, if storage is necessary for more than one season, and if the corn is dry enough for safe storage it should be shelled, stored in a tight bin, and fumigated.

FUMIGATION [3]

For the treatment of infested corn or wheat in storage on the farm there is nothing cheaper, more effective, or more readily available than carbon disulphide.

Although the fumes of carbon disulphide are inflammable and explosive when mixed with air in certain proportions, this fumigant can be handled with reasonable safety if the proper precautions are taken. It should not be used to treat bins located in barns where the fire hazard cannot be properly controlled and where a fire or explosion will lead to serious losses of farm animals, farm equipment, buildings, and stored crops. Fire insurance may be voided on buildings in which carbon disulphide is used. It is well adapted, however, for the treatment of grain storages that are segregated from other farm buildings. The fumes of this gas are quickly absorbed by the grain after it is applied and the danger from fire or explosion is not prolonged.

If grain bins are located on farms where the fire hazard cannot be controlled, a mixture of carbon disulphide and carbon tetrachloride or a mixture of ethylene dichloride-carbon tetrachloride should be used. When used as grain fumigants, these mixtures do not have the fire hazard of carbon disulphide. They are not as toxic as carbon disulphide alone, must be used in larger quantities, and hence are more expensive.

Carbon disulphide.—Carbon disulphide is a colorless, volatile liquid, which boils at 115° F. On exposure to air it evaporates, thus forming a heavy vapor that is capable of penetrating through deep bins of grain and that is highly toxic to insects.

It is applied by sprinkling it evenly over the surface of the grain in the bin by means of a watering can or similar device at the rate of from 1 to 3 gallons per 1,000 bushels of grain, depending upon the temperature of the grain and the tightness of the bin. The cooler the corn the larger the dosage that is required; fumigations at temperatures below 60° F. are not highly effective. The use of a tarpaulin to cover the grain after the fumigant is applied will aid in confining the vapor.

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[3] For further information on control of insects see Farmers' Bulletin 1811, Control of Insects Attacking Grain in Farm Storage.

The vapors of carbon disulphide are poisonous to human beings if breathed for an extended period. Exposure to light concentrations may induce a feeling of giddiness, which, however, will quickly pass off on one's coming out into the fresh air. Small quantities of carbon disulphide can be handled without danger by the ordinary person, but persons having any heart trouble should take little part in its application.

Carbon disulphide weighs about 10½ pounds per gallon and ranges in cost from about 6 cents per pound in 500-pound lots to 30 cents per pound in 1-pound lots.

Remember, lighted lanterns, sparks from electric switches, sparks formed by hammering upon metals, lighted cigars, and static and frictional electricity may cause an explosion of carbon disulphide vapor; therefore fire in any form, or excessive heat, or frictional or static electricity should not be allowed near a bin or building that is being fumigated with this chemical.

Mixtures of carbon disulphide with other chemicals.—Mixtures of carbon disulphide with other chemicals such as carbon tetrachloride and sulphur dioxide for the purpose of reducing the fire hazard are now available commercially at a price of about $2 per gallon f. o. b. the factory. These mixtures consist of approximately 20 percent carbon disulphide and 80 percent carbon tetrachloride to which may be added a small quantity of sulphur dioxide or other chemicals. When properly made such mixtures appear to be relatively free from fire hazard. It is not advisable for the laymen to attempt the manufacture of such mixtures, since the safety of the fumigant is dependent upon its proper preparation. Only such mixtures as are sanctioned by fire-insurance underwriters should be used.

They should be used at the rate of from 3 to 5 gallons per 1,000 bushels according to the temperature of the grain and the tightness of the bin if results comparable to those obtainable from the carbon disulphide alone are to be obtained. The fumigant is applied in the same manner as carbon disulphide—by sprinkling it evenly over the surface of the grain.

Ethylene dichloride-carbon tetrachloride mixture.—Ethylene dichloride, a recently discovered fumigant, is effective in tight bins at temperatures above 70° F. Since the vapors of ethylene dichloride are slightly inflammable, it is customary to use this fumigant in combination with carbon tetrachloride. A mixture of 3 parts by volume of ethylene dichloride with 1 part of carbon tetrachloride is free from fire hazard under ordinary conditions. It can be used as a substitute for carbon disulphide in circumstances where carbon disulphide cannot safely be used.

Ethylene dichloride is a colorless liquid with an odor similar to that of chloroform. It evaporates slowly when exposed to air, forming a vapor that is heavier than air and that will penetrate grain in a manner similar to carbon disulphide vapor.

In admixture with carbon tetrachloride it should be used at the rate of from 3 to 5 gallons per 1,000 bushels of grain and can be applied in the same manner as carbon disulphide.

It can be purchased in 55 gallon drums at a cost of 6½ cents per pound delivered.

Fumigation of corn in small elevators.—In some regions grain is stored on the farm in small elevators that are equipped with machinery for handling grain and transferring it from one bin to another. The bins in such elevators are usually of the open-top, crib type and have a capacity of about 5,000 bushels. Corn stored in such elevators can be treated in a different manner from corn in farm storage that cannot be handled. Fumigants can be applied to the grain as the bins are filled, so that good distribution of the fumigant is possible, and there is a choice of chemicals. One of the most satisfactory grain fumigants under these conditions is a mixture of carbon disulphide and carbon tetrachloride and sulphur dioxide.

If the carbon disulphide-carbon tetrachloride-sulphur dioxide mixture is used, it can be applied entirely to the surface of the corn of the filled bin in the same manner recommended for the treatment of smaller farm bins. A dosage of 2 gallons of the mixture per 1,000 bushels of grain is recommended. If the corn is warm the surface method of application will give satisfactory results. If the corn is cool or cold, better distribution of the fumigant can be obtained by spraying, pouring, or dripping it into the grain stream as the grain is transferred from one bin to another.

SPRAYS

Sprays used in treating empty bins should not be of a type likely to contaminate or impart an odor to the grain that will be placed in storage. Since oil sprays are inflammable, precautions against fire should be taken in applying such a spray.

Any highly refined odorless and tasteless petroleum oil (similar to that used in commercial fly sprays for use in dwellings) to which has been added a small quantity of pyrethrum extract makes a satisfactory spray.

POSSIBILITY OF LOANS THROUGH FEDERAL CREDIT AGENCIES FOR CONSTRUCTION OF STORAGE FACILITIES

Farmers unable to finance storage structures through their own resources may be eligible for loans from the Farm Credit Administration, the Farm Security Administration, or lending agencies insured by the Federal Housing Administration. Information regarding such loans may be secured from county agricultural conservation committees or from county agents.

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